An Optimization Model for a Forward Supply Chain Management System

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Abstract - *Product distribution plays an important role in supply chain management from a manufacturing house to the demand market. A manufacturing house can produce either a huge amount of similar products or different types of products for their managerial benefit. In this paper, a general single-item supply chain network model is formulated which includes single manufacturer, single distributor and single retailer but multiple customers. Here, single types of products are produced according to the customer requirements. Then the products are distributed to the distributor and then to the retailer after that the customers receive it according to their demand. No reverse logistics are considered. The objective of this paper is to minimize the overall cost for the entire supply chain network. Shortages are not allowed here. Finally, the model is illustrated with a numerical example.*

***Key Words*: Supply chain network, Shortages, Reverse logistics, Managerial Benefits, Product distribution.**

1. INTRODUCTION

The process of the traditional supply chain depends on the planning, implementing and controlling of the flow of product from the manufacturing house to the demand market. The flow of product may either be in a forward direction or in a reverse direction. The reverse direction of the product is specifically used for the returned product which has the necessity to be remanufactured for further use. But, in this paper, we focus on the forward direction of the product rather than the reverse one. It is important to make the co-ordination between all the participants who are involved in the supply chain model partially or fully. To develop the system performance of the entire supply chain management every manufacturer has the responsibility to co-operate with the suppliers to improve their productivity and make customer satisfaction at a nominal cost.

Co-ordination among all entities in a supply chain is developed in Thomas and Griffin [10] where their target to improve the effective co-operation among all entities in the supply chain management.

A supply chain model with multiple suppliers and multiple vendors is developed in Pan [8]. In this paper, the objective of this model is to improve the reliability of the supplier for supplying the critical materials for producing the product according to customer satisfaction.

A single objective mixed-integer programming problem in a supply chain environment is developed in Narasimhan and Stoynoff [7]. The objective of this model is to minimize the total cost including the transportation cost and the penalty cost of the supply chain model.

A dynamic programming problem with fluctuating prices in supply chain management is formulated in Kingsman [6]. In this paper, the model is considered in a stochastic manner over time.

A seller-buyer supply chain model with a specified time horizon is developed in Buffa and Jackson [1] where the solution of the model is done using a goal programming approach.

Multi-Objective mixed-integer linear programming problem for order allocation is developed in Demirtas and Ozden [2]. The objective of this model is to optimize the order quantities under the deterministic constraints.

Single manufacturer with multiple plants in a supply chain environment is developed in Kim et al. [5]. In this paper, they determine the length of the production cycle for the manufacturer to distribute the product to the retailer. The objective of this paper is to minimize the overall cost of the entire supply chain environment.

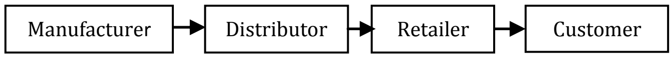
The co-ordination model between multiple suppliers is designed in Herer et al. [3] where the rate of production is considered as linear to each supplier.

Multi-objective decision making approaches for a supplier selection problem is developed in Ho et al. [4].

A seller-buyer optimization model is developed in Sarkis and Semple [9]. In this paper, the volume of the product is discounted with a certain percentage for marketing aspects. The model is considered in a single time horizon and the total cost in inventory is not dependent with other costs in the entire supply chain network.

In this paper, we develop a supply chain model consisting of a single manufacturer, a single distributor and a single retailer with multiple customers. The objective of this model is to minimize the overall cost of the entire supply chain management. The model is considered with single item. Finally, we verify our model with a numerical example.

2. MODEL DESCRIPTION



The products are manufactured by a manufacturer in a manufacturing house and then these products are distributed to the distributor. The retailer receives the products from the distributor for the distribution of the customer. Finally, the customers receive their products through the retailer according to their needs. In this paper, no reverse procedure are considered i.e., if the products are not reached to the satisfaction level of the customer, the product is not considered for remanufacturing. All the products are manufactured according to customer demand and all products are reached to customer satisfaction.

2.1. NOTATIONS

(i) Z=Total Cost for the entire supply chain model

(ii) C_{jk}=Production cost per unit item for jth product, kth customer

(iii) O_{jk}= Ordering cost per unit item for jth product, kth customer

(iv) F_{jk}=Transportation cost per unit item for jth product, kth customer

(v) N_{jk}=Total number of transportation for jth product to kth customer

(vi) D_{jk}= Total number of demand for jth product of the kth customer

(vii) Q_{jk}= Total quantity of the jth product to be distributed to the kth customer

(viii) P_{jk}=Total number of jth product is manufactured for the kth customer

2.2. MODEL FORMULATION

Minimize Total Cost= Production Cost +Ordering Cost +Transportation Cost

subject to Unit of Production>=Demand of Customer

i.e., Minimize

$$Z = \sum_{j=1}^{1}\sum_{k=1}^{3} C_{jk} \times P_{jk} + \sum_{j=1}^{1}\sum_{k=1}^{3} O_{jk} \times \frac{D_{jk}}{Q_{jk}} + \sum_{j=1}^{1}\sum_{k=1}^{1} F_{jk} \times N_{jk} \times \frac{D_{jk}}{Q_{jk}} \qquad (1)$$

subject to

$$\sum_{j=1}^{1}\sum_{k=1}^{3} P_{jk} \geq \sum_{j=1}^{1}\sum_{k=1}^{3} D_{jk} \qquad (2)$$

Here, equation (1) represents the objective function of our model and the equation (2) represents the constraints of our model. Our objective is to minimize the total cost of the entire supply chain model under one constraint. The constraint is the number of products are produced in a manufacturing house are always greater than the demand of the customer, i.e., shortages are not allowed. The model is considered for single product but the number of customer will be three. Finally, the model is verified using a numerical example.

3. RESULTS

Value of the input parameters:

$C_{11} = 180, C_{12} = 186, C_{13} = 182, O_{11} = 140, O_{12} = 143, O_{13} = 144, F_{11} = 120, F_{12} = 125, F_{13} = 128,$

$D_{11} = 30,\ D_{12} = 32,\ D_{13} = 30.$

Table -1: Optimal Solution:

	P_{jk}	Q_{jk}	N_{jk}
j=1, k=1	50	20.26	11
j=1, k=2	55	19.67	10
j=1, k=3	52	23.75	12

4. CONCLUSIONS

Here, the model is developed for a single product but with multiple customers in a supply chain environment. The product is produced in a huge amount in a manufacturing house so that shortages have not occurred. It is assumed that all the products which are manufactured are to be a perfect one, but in real situation, it is not always possible. The model is considered as a forward direction but the model is extended on reverse flow also where the product may be remanufactured for a future aspect. We have applied LINGO software for a method of a solution but we can apply some advanced techniques for the solution of our model. In this paper, we have considered the products are in deterministic in nature but these are not always true in a real scenario. We may consider our model in an uncertain environment for the future extension of our model.

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